Seafloor Reconnaissance Surveys and Change Monitoring Using a Small AUV and a Small ROV

Grant Number: N00014-05-1-0665

Acquisition of a REMUS Autonomous Underwater Vehicle and a Small ROV for the University of Hawaii

Grant Number: N00014-04-1-0820

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LONG-TERM GOALS

Early in 2005 the University of Hawaii purchased a REMUS autonomous underwater vehicle (AUV) and a SeaBotix LBV150S remotely operated vehicle (ROV) with ONR DURIP funding. The instruments are particularly useful for work in coastal waters up to 100m in depth. The AUV provides high-resolution bottom sidescan sonar maps and water column data. The ROV will be used to ground-truth targets picked from backscattered imagery. The littoral environment has become an area of intense interest to naval forces since the end of the Cold War in the early 1990's. Ship To Objective Maneuver and Mine Warfare are two primary applications of data from the near shore. Additionally, the NAVY and DoD in general have been increasingly involved in environmental issues such as reclamation of formerly used defense sites (FUDS) and the spread of water-borne pollution. Homeland

Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 2005		**00-00-2005 to 00-00-2005**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Seafloor Reconnaissance Surveys and Change Monitoring Using a Small AUV and a Small ROV	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of Hawaii,Hawaii Institute of Geophysics and Planetology,1680 East West Rd,Honolulu,HI,96822**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
code 1 only

14. ABSTRACT

Early in 2005 the University of Hawaii purchased a REMUS autonomous underwater vehicle (AUV) and a SeaBotix LBV150S remotely operated vehicle (ROV) with ONR DURIP funding. The instruments are particularly useful for work in coastal waters up to 100m in depth. The AUV provides high-resolution bottom sidescan sonar maps and water column data. The ROV will be used to ground-truth targets picked from backscattered imagery. The littoral environment has become an area of intense interest to naval forces since the end of the Cold War in the early 1990's. Ship To Objective Maneuver and Mine Warfare are two primary applications of data from the near shore. Additionally, the NAVY and DoD in general have been increasingly involved in environmental issues such as reclamation of formerly used defense sites (FUDS) and the spread of water-borne pollution. Homeland security also has a stake in understanding and monitoring coastal shallow waters. Our long term goal is to develop the expertise to easily deploy our assets in the field for economical and rapid data reduction and assessment of areas of interest to the Navy, other governmental agencies, and the research community.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**7**	

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OBJECTIVES

Objectives during the past year were to

(1) adapt custom sidescan sonar software used by the Hawaii Mapping Research Group (HMRG) for use with REMUS data,

(2) begin a time series of sidescan surveys off Kakaako (Oahu) around the Kilo Nalu Cabled Reef Observatory, and

(3) develop techniques to ground truth targets seen in sidescan surveys with the ROV.

APPROACH

Raw data from the sidescan system aboard the REMUS is translated into a standard HMRG format. Data are then processed to form mosaics of bottom sidescan. Both raw and processed data are examined for the location of man-made targets and to characterize sand texture. Targets are then examined using the ROV. Repeat surveys will be done on a monthly basis and/or before and after storm events. Objects will be placed on the seafloor in sandy areas to document scour and burial over time.

WORK COMPLETED

Algorithms to reformat raw REMUS sidescan data have been written. We are in the process of writing batch processing scripts that will allow rapid initial looks at seafloor mosaics. HYDROID supplies software to look at individual data files that are useful for target identification, but the files are not geographically registered. Now that we have access to HMRG software we continue to hone our data reduction skills. By adapting HMRG codes, we also have the added benefit of free access to the HMRG programmers and the potential for REMUS-specific processing adaptations in the future.

The area around Kilo Nalu was surveyed during REMUS training in March, 2005. We then underwent a pause in operations while we organized insurance for the vehicle and developed the software. A second Kilo Nalu survey was conducted in September - meant to be the first of the time series. The REMUS experienced a total systems failure about 45 minutes into the mission. We were able to recover it (floating dead on the surface - no transponder) and it is currently being shipped to HYDROID for troubleshooting and repair.

RESULTS

A target picked out of the March, 2005, data is shown in Figure 1. We used REMUS software to identify the location of the target and then visited it with our ROV. A still frame for the ROV video is also shown in Figure 1 (a video clip is available at www.soest.hawaii.edu/wilkens/targets). At least in Hawaiian waters, where visibility is generally good, finding sidescan targets with the ROV is fairly simple.

There were some data collected in September before REMUS failed. A comparison of images of the same section of seafloor in March and September is shown in Figure 2. These images are not plotted in geographic coordinates, but rather are referenced to the AUV. The main contrast between the images is in the sandy arras. In March the sand was covered in ripples, including an interesting herringbone pattern (lower right). In September the ripples were not present. Other areas (not illustrated) suggest that the sand may have been a little deeper during the earlier survey as well. What we do not know at this time is whether the differences we see are seasonal or related to the wave climate immediately before each survey. Repeated surveys will answer those questions once REMUS is returned to duty.

An example of a section of mosaic from the March data is presented in Figure 3. In this instance both port and starboard swaths have been incorporated to give full coverage. Doing this means that some areas are illuminated from the southeast while others are illuminated from the northwest. Future repeat surveys will be done at close enough intervals that 2 separate mosaics can be formed - one from each look direction. The sand field with herringbone ripples illustrated in Figure 2 is just above the "X" in Figure 3.

IMPACT/APPLICATIONS

We have introduced the combined REMUS and LBV 150 system to the local office of the US Army Corps of Engineers. They have shown a great deal of interest in using the equipment to survey for unexploded ordnance off Oahu and the island of Hawaii. We had scheduled 2 weeks on Hawaii in October to perform some preliminary work, but will be delayed until December due to the REMUS technical problems.

RELATED PROJECTS

Sand Distribution and Statistical Spatial Characteristics on Pacific Reef Platforms. Charles Fletcher - P.I. We will be using the techniques and software developed in this project to map sand deposits over a wide area of Oahu coastline. www.soest.hawaii.edu/coasts/cgg_main.html

Wave Boundary Layer Processes Over an Irregular Bottom. Geno Pawlak -P.I. The Kilo Nalu observatory is recording environmental data in the area where we will be doing the time series observations, providing us with inputs to models of ripple development as we begin to build a data set. oe.eng.hawaii.edu/~gpawlak/index.html

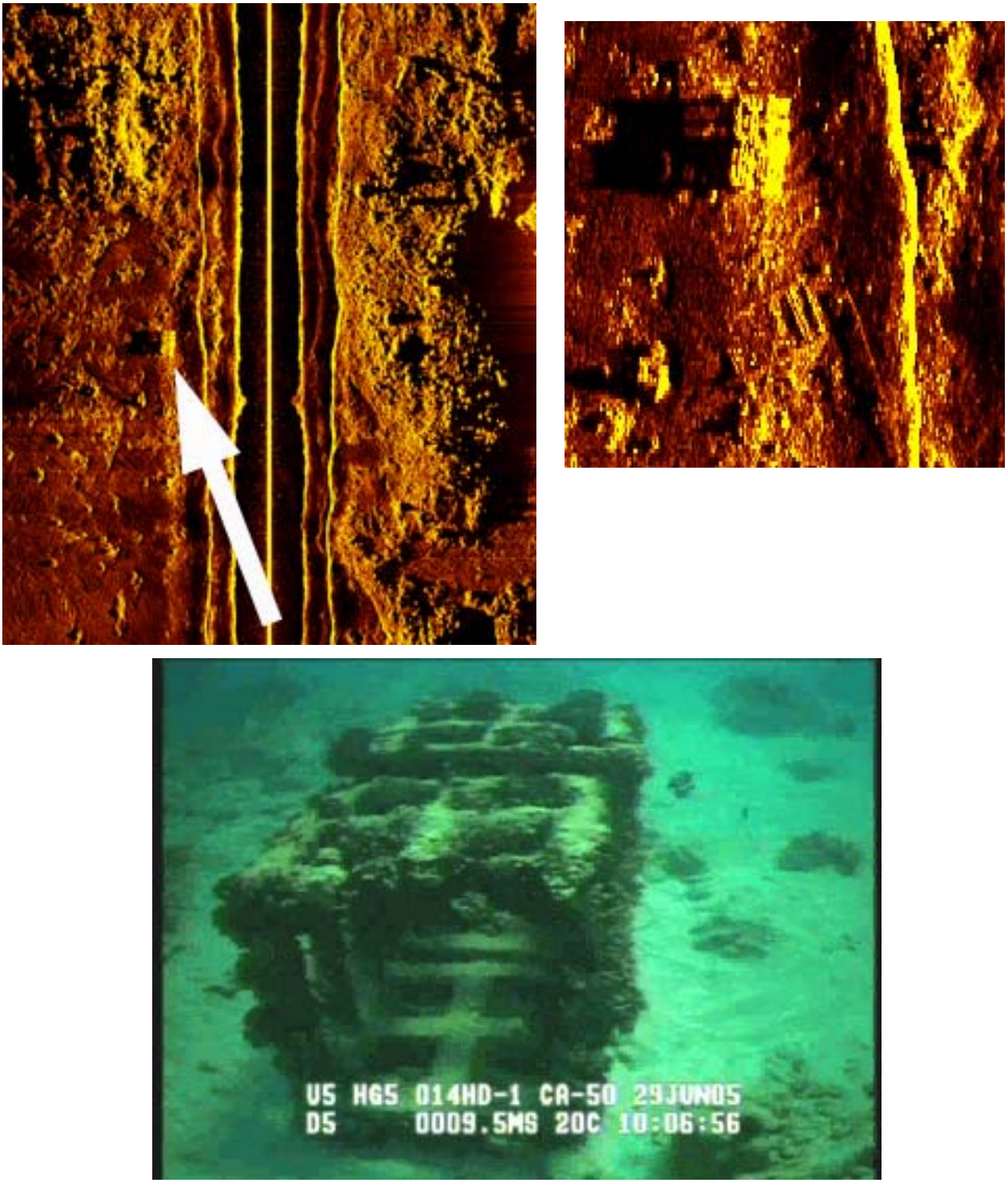

Figure 1. Upper left - a rectangular target seen in a section of sidescan data from the REMUS AUV. Object is approximately 1.0 X 0.5 X 0.5 m. Upper right - detail of object from sidescan data. Image suggests an open framework texture. Bottom - still frame from ROV video of sidescan target showing

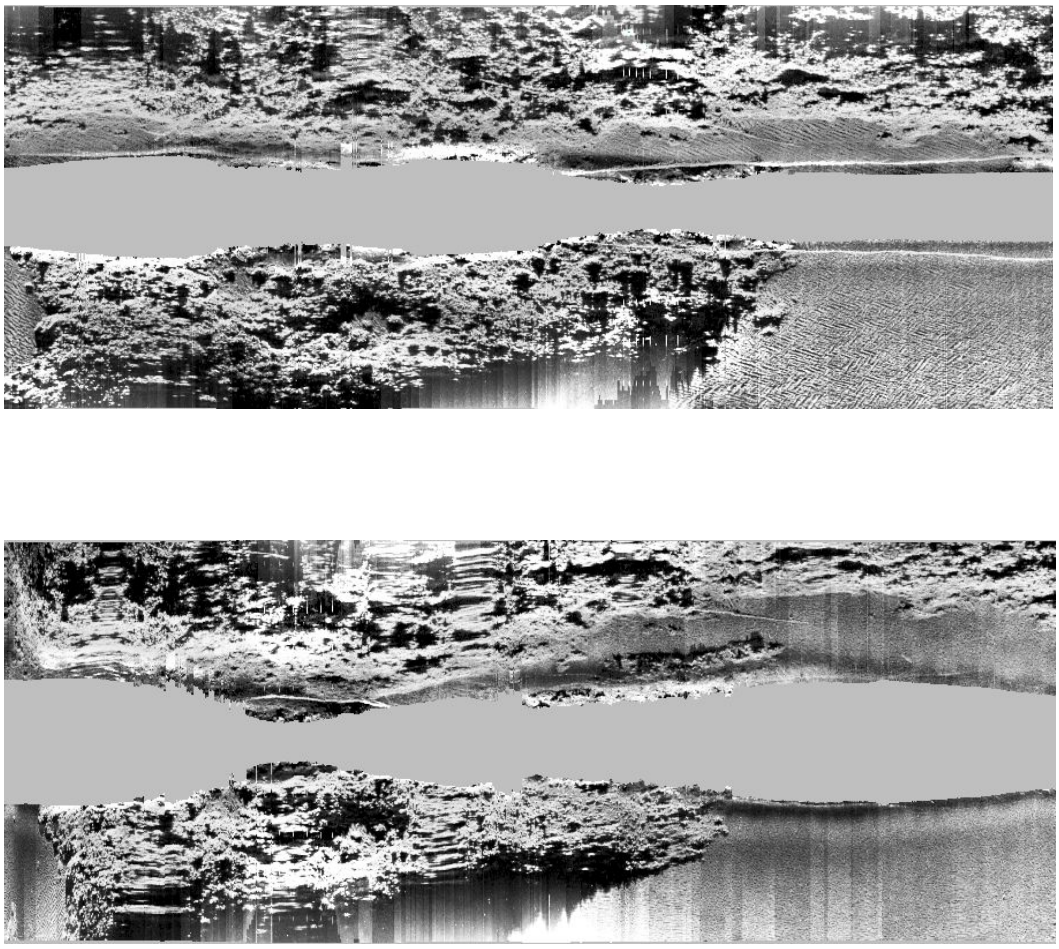

Figure 2. Top - section of sidescan data collected in March, 2005. These data have been processed to remove the nadir line, but have not been converted to a geographic coordinate system. The image shows parts of a coral reef and a sand field to the right that is crosshatched with ripples. Bottom - the same section of seafloor from a sidescan survey done in September, 2005. The sandy portion of the image does not have the rippled pattern seen in earlier data. Images are 60 X 150 m.

Figure 3. A section of sidescan mosaic from the March, 2005 mission. The sidescan image shows both reef and sand fields. The area examined in Figure 2 is above the X in the center of the mosaic.